AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

	1. CONTRACT ID CODE	PAGE OF PAGES
	J	1 / 45

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO.(If applicable)
U0001	16-Nov-2005		

6. ISSUED BY	CODE	N65540	7. ADMINISTERED BY (If other than item 6)	CODE	

NAVAL SURFACE WARFARE CENTER, CARDEROCK
CODE 3351, ELIZABETH J. YOUSE
5001 SOUTH BROAD ST.
PHILADELPHIA PA 19112-1403

See Item 6

8. NAME AND ADDRESS OF CONTRACTOR (No., Street, County, State and Zip Code)		
	X	9A. AMENDMENT OF SOLICITATION NO. N65540-05-R-0029
	X	9B. DATED (SEE ITEM 11) 02-Nov-2005
		10A. MOD. OF CONTRACT/ORDER NO.
		10B. DATED (SEE ITEM 13)

CODE	FACILITY CODE

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

[X] The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offer [ ] is extended, [X] is not extended.

Offer must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended by one of the following methods:
(a) By completing Items 8 and 15, and returning __2__ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted;
or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE
RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN
REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter,
provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS.
IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE
    CONTRACT ORDER NO. IN ITEM 10A.

B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying
    office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(B).

C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:

D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor [ ] is not, [ ] is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter
    where feasible.)

This amendment is being issued to amend the Procurement Specification included as Section C of the Solicitation to clarify that MIL-STD-108
applies to enclosures designated "submersible" while NEMA 4 applies to enclosures designated "drip proof."

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)	16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)
	TEL: EMAIL:

15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA BY	16C. DATE SIGNED
(Signature of person authorized to sign)		(Signature of Contracting Officer)	

EXCEPTION TO SF 30
APPROVED BY OIRM 11-84

30-105-04

STANDARD FORM 30 (Rev. 10-83)
Prescribed by GSA
FAR (48 CFR) 53.243

SECTION SF 30 BLOCK 14 CONTINUATION PAGE

SUMMARY OF CHANGES

SECTION C - DESCRIPTIONS AND SPECIFICATIONS

The following have been modified:
    <u>PROCUREMENT SPECIFICATION</u>

PROCUREMENT SPECIFICATION

FOR

MACHINERY CONTROL SYSTEM

ON US NAVY SHIPS

TABLE OF CONTENTS

1. GENERAL SPECIFICATIONS

1.1 This specification has been developed to establish minimum hardware requirements for a Machinery Control System (MCS) that will control the auxiliary machinery equipment onboard CVN-68 Class ships. The MCS includes, but is not limited to, the Fireman System, Interior Communication/Standard Module (IC/SM) Alarm Monitoring System, List Control System, JP-5 System, and Data Acquisition System (DAS), currently the Integrated Condition Assessment System (ICAS). The objective of the new Control System will be to improve reliability, maintainability, and efficiency by reducing Total Ownership Cost (TOC) and downtime. The new system shall be designed to easily interface with existing shipboard systems. A laboratory version of the shipboard control system will be installed at NSWCCD Philadelphia.

1.2 The MCS will be comprised of multiple Programmable Logic Controller (PLC) based units. The PLC units will consist of a group of Input/Output (I/O) enclosures, one or more of which will contain a PLC processor. These groups will communicate via Industrial Ethernet (IE). Computer workstations and Operator Interface Panels (OIPs) will interface between the machinery operators and the PLC processors. Communication between the I/O enclosures, PLC processors and OIPS will be performed through IE Switch Enclosures. A PLC group shall be designated as one or more processors, a variable number of enclosures containing field I/O and an IE Switch providing communication between the various elements of the group, any local operator computers and the ship's fiber optic MCS Local Area Network (LAN).

1.3 Industrial Ethernet switches shall be installed in an enclosure. The enclosure shall contain all terminations, power supplies, and ancillary devices needed to safely operate the switch and interface with the external devices. Two sources of power (AC and/or DC) are required for each IE enclosure. If either source is momentarily or permanently disrupted, the switch will continue operating without interruption. The primary power source for the switch will be 24 VDC, although AC sources may be supplied to the enclosure and converted to DC within the enclosure. An industrial or military grade Automatic Bus Transfer (ABT) may be used to accomplish this switchover. The IE enclosure shall be required to accept copper type CAT-5 (MIL-DTL-24643B) and fiber optic (MIL-PRF-85045F and MIL-PRF-49291) cabling and terminations. The CAT-5 connections will require a means of interfacing with shielded CAT-5 watertight cable (MIL-DTL-24643B), via interface terminal. The fiber optic connections shall be of the military grade ST (MIL-C-83522/16B) type. All components within the enclosure shall be finger-safe or covered with a protective, non-conducting material (e.g. lexicon) to prevent incidental contact with energized surfaces during routine maintenance for components containing voltage levels greater than 30 VDC.

1.4 I/O enclosure containing a PLC processor — This enclosure shall consist of an I/O chassis, I/O modules (Discrete and Analog), PLC Processor and supporting power supplies. The enclosure shall contain all necessary hardware to interface with the field machinery including terminal block/strips for terminating all required field wiring, power supplies required for loop and I/O power, and any necessary relays, transducers or other electronics. The I/O enclosure shall be required to accept copper type CAT-5 (MIL-DTL-24643B) or fiber optic (MIL-PRF-85045F and MIL-PRF-49291) cabling and terminations. Two independent Ethernet communication paths will be required; one to communicate with the OIPs, computer workstations and the ship's LAN; the other to communicate with other remote I/O enclosures within the group that do not contain PLC processors via an IE enclosure. Two sources of AC power will supply the I/O enclosure. The PLC processor, I/O modules, power supplies and all supporting equipment must maintain operation in the event of a momentary or permanent power loss to either source without interruption. An industrial or military grade ABT may be used to accomplish this

switchover. All components within the enclosure shall be finger-safe or covered with a protective, non-conducting material (e.g. lexicon) to prevent incidental contact with energized surfaces during routine maintenance for components containing voltage levels greater than 30 VDC.

1.5   I/O enclosure without a PLC processor — This enclosure shall consist of an I/O chassis, I/O modules (Discrete and Analog) and supporting power supplies. The enclosure shall contain all necessary hardware to interface with the field machinery including terminal block/strips for terminating all required field wiring, power supplies required for loop and I/O power, and any necessary relays, transducers or other electronics. The I/O enclosure shall be required to accept copper type CAT-5 (MIL-DTL-24643B) or fiber optic (MIL-PRF-85045F and MIL-PRF-49291) cabling and terminations. One Ethernet communication path will be required to communicate with I/O enclosure(s) containing the PLC processor via the IE enclosure. Two sources of AC power will supply the I/O enclosure. The I/O modules, power supplies and all supporting equipment must maintain operation in the event of a momentary or permanent power loss to either source without interruption. An industrial or military grade ABT may be used to accomplish this switchover. All components within the enclosure shall be finger-safe or covered with a protective, non-conducting material (e.g. lexicon) to prevent incidental contact with energized surfaces during routine maintenance for components containing voltage levels greater than 30 VDC.

1.6   For the typical CVN, 12 I/O groups are required for the MCS. The composition of these groups, including the Industrial Ethernet components, are included in Attachments 11.1 through 11.3. The final configuration is subject to change and will be determined by the government In Service Engineering Agent (ISEA).

1.7   The MCS shall be connected to a government furnished fiber optic Ethernet LAN that will provide inter-PLC communications as well as communications with Windows XP Embedded™ based processors. The Windows XP Embedded™ based processors will contain the Human Machine Interface (HMI) computer program. The Windows XP Embedded™ based processors and HMIs shall be provided and developed by the government ISEA.

1.8   The I/O enclosure shall maximize available space. The requirements for non-isolated I/O and the enclosure limits are as follows:
24" x 24" x 8" (96 points of I/O)
30" x 36" x 8" (160 points of I/O)
The exact distribution of I/O modules is contained in Attachment 11.1. Additionally, the internal health of the I/O enclosure shall be monitored. At a minimum, all power supplies, with the exception of the PLC chassis power supply and the primary/secondary sources to the I/O enclosure, will be monitored for their state. Either analog or discrete I/O may be used to accomplish this.

A rack mounted I/O design is also required to monitor IC/SM alarm signals. This I/O rack will be mounted in Damage Control Central (DCC) and would take advantage of the existing cable run for IC/SM alarm monitoring. The I/O rack will meet the same environmental specifications as the I/O enclosures. A minimum of 240 IC/SM alarm signals will populate the I/O rack and shall not exceed 63 inches in usable rack height (36U). A means of isolating grounds between signals must also be included. This may be accomplished either by automatically placing the grounded signal in cutout or isolating each channel including sense voltage from the others. The subcomponents of this I/O rack must include the same requirements as the I/O enclosures (i.e. dual sources of AC power and connectivity).

1.9   The I/O enclosures shall interface with various I/O signal types as defined by various

terminal harnesses. The harness types will be used in the contractor's design documentation. All discrete type signals shall be software configurable for either latching or momentary type action. The harness shall consist of finger-safe, DIN rail mounted wiring terminals as well as required wiring between aforementioned wiring terminals and the respective I/O module channels. Every module channel shall be wired to terminals, even if the channels are currently unused. The hot side of every AC and DC signal shall be fused with a blown fuse indicator. The neutral side of every AC signal (but not the neutral side of DC signals) shall be fused with a blown fuse indicator. Light Emitting Diode (LED) type fuse indicators will be used for all DC signals and Neon type fuse indicators will be used for all AC signals. The fuse size required shall be marked on every fuse holder. The fuse holder shall be either hinged or removable to gain access to the fuse. Analog signals shall have grounding terminals throughout the terminal board to allow for no greater than 4 inches from the signal connections to the shield drain wire. The harness types and descriptions that will be used are as follows:

1.9.1   Harness Type (IAN): Non-Isolated 115 VAC Input with internally sourced voltages from within the I/O enclosure to the field device, across dry contacts

1.9.2   Harness Type (IAI): Isolated 115 VAC Input with externally sourced voltages from the field

1.9.3   Harness Type (IDN): Non-Isolated 24 VDC Input with internally sourced voltages from within the I/O enclosure to the field device, across dry contacts

1.9.4   Harness Type (ISN/QDN/QDN32): A pair of harnesses that perform the following function (note that the QDN32 is rack mount only, and the QDN is wall mount only): Non-Isolated Supervisory Input with internally sourced voltages (of less than 30 VDC) from within the I/O enclosure to the field device, across dry contacts with a 6.8 KOhm resistor installed in the field parallel to the contacts. The circuit shall be capable of detecting open contacts, closed contacts and broken wires. A means of isolating grounds between signals must also be included. This may be accomplished either by automatically placing the grounded signal in cutout or isolating each channel including sense voltage from the others

1.9.5   Harness Type (QAN): Non-Isolated 115 VAC Output with internally sourced voltages from within the I/O enclosure to low current field coils (2 Amp resistive or inductive steady state)

1.9.6   Harness Type (QKW): Isolated Normally Open (NO) dry contact outputs interfaced with externally sourced voltages supplied into the I/O enclosure. The externally sourced voltages can range from 5 VDC to 115 VAC. The maximum current across the contacts will be 2 Amp resistive or inductive steady state. 1000 VDC of isolation between channels is required at a minimum

1.9.7   Harness Type (QKX): Isolated Configurable Contact with either Normally Open (NO) or Normally Closed (NC) Output interfaced with externally sourced voltages supplied into the I/O enclosure. The externally sourced voltages can range from 5 VDC to 115 VAC. The maximum current across the contacts will be 2 Amp resistive or inductive steady state. 1000 VDC of isolation between channels is required at a minimum

1.9.8   Harness Type (QK6): Isolated Configurable Contact with either Normally Open (NO) or Normally Closed (NC) Output interfaced with externally sourced voltages supplied into the I/O enclosure. The externally sourced voltages will be 115 VAC with a maximum current across the contacts of 6 Amp resistive or inductive steady state. 1000 VDC of isolation between channels is required at a minimum

1.9.9   Harness Type (ACN): Non-Isolated Analog 4-2OmA DC Input through two wire current sink with an internally sourced 24 VDC voltage supplied from within the I/O enclosure. The input module shall have under-range and over-range capability and a 16 bit Analog to Digital (A/D) converter

1.9.10   Harness Type (AVN): Non-Isolated Analog 0-I0VDC Input through three wire voltage source with an internally sourced I0VDC voltage supplied from within the I/O enclosure. The input module shall have under-range and over-range capability and a 16 bit Analog to Digital (A/D) converter

1.9.11   Harness Type (AR3): Isolated Analog Resistance Temperature Detector (RTD) Input through three wires (i.e. signal, common and compensation). The input module will compensate for losses due to cable distance and will have under-range and over-range capability and a 16 bit Analog to Digital (A/D) converter. The input module will be configurable for various RTD types and will include 100 Ohm platinum (385 curve), 100 Ohm platinum (392 curve) and 120 Ohm nickel (672 curve). Each module channel shall be configurable to a unique curve. 1000 VDC of isolation between channels is required at a minimum

1.9.12   Harness Type (AOC): Isolated Analog Output capable of 0-200µAmp DC, 4-20mA DC or 0-10VDC. Resistors may be used to modify the ranges. The output module shall have a 16 bit or greater resolution Discrete to Analog (D/A) converter. 1000 VDC of isolation between channels is required at a minimum

1.9.13   Harness Type (ACI): Isolated Analog Input capable of ranges of either 4-20mA DC or 0-10VDC. The input module will be configurable to switch between current and voltage inputs without using module jumpers and will have a 16 bit Analog to Discrete (A/D) Converter. 1000 VDC of isolation between channels is required at a minimum

1.10   There are approximately 3800 auxiliary machinery plant signals that require interface with the MCS. The signals are distributed among the approximately 70 I/O enclosures that make up a typical MCS ship set. The specific I/O signal list will be provided within 30 days after contract award.

2. ENCLOSURE MATERIAL AND DESIGN

2.1   Various I/O enclosure sizes are required for MCS installations onboard the CVN-68 Class vessels. All I/O enclosures must be capable of containing a PLC processor and the necessary supporting components to ensure that the processor can control the I/O group. An enclosure that contains a PLC processor shall have an additional Ethernet connection and an RTD installed in the I/O enclosure to monitor the internal ambient temperature. The RTD shall be a 100 Ohm platinum type referenced to either the DIN385 or DIN392 curves.

2.2   All I/O enclosures shall have a 3/16" diameter grounding stud mounted on the rear of the enclosure, outside of the shock envelope, which will be wired to the enclosure grounding bus. The front panel of hinged enclosures shall have a safety ground connected to a grounding bus. Safety grounds will be installed on all 24 VDC power supplies, I/O chassis and I/O power supplies. All grounding locations shall be properly cleaned of paint, coating etc. to ensure a proper bond.

2.3   All I/O enclosures shall contain DIN rail mounting for field interface components such as terminals, herein referred to as "terminal boards". All terminal boards shall be clearly labeled. All terminal boards shall not contain exposed sharp edges. All terminal boards shall have end barriers and end clamps.

2.4   All I/O enclosure terminal boards will be clearly labeled with the terminal board number and fuse size (where required). Terminal boards will consist of straight through feeds, fused feeds, relays and/or ground terminals. Straight through feed terminal boards will be used for all DC returns, RTD signals and voltage inputs. Fused terminal boards with blown fuse indicators will be used for all DC excitation points and both sides of all AC signals. Relays shall be used for all field interface signals exceeding the I/O module specifications or to isolate supervisory inputs from the rest of the I/O enclosure components. Straight through ground terminal boards shall be installed at locations throughout any analog terminal board that are connected to the I/O enclosure ground bus. Main power distribution will use two-layer straight through feed terminal boards between the source and the individual terminal boards. The source power to or from the enclosure shall be fused with hinged blown fuse indicators for both the power and return wires.

2.5   All I/O enclosures containing supervisory inputs shall either utilize isolated power and modules to monitor those signals or shall monitor the state of the power source to determine if the power source is grounded.

2.6   I/O enclosures that require fiber connectivity shall interface directly with an Ethernet module or will have a DIN rail mounted, fiber to copper media converter. The fiber end connector shall be military grade ST (MIL-C-83522/16B) type.

2.7   All optional components shall have their mounting support equipment installed even if the optional components are not installed. For example, a 24 VDC field power supply mounting kit shall be installed in each enclosure even if that enclosure does not currently require one.

2.8   The following I/O enclosure sizes shall be supported:

2.8.1   A 24"x24"x8" submersible (per MIL-STD-108E, Notice 1) enclosure shall be designed with a removable cover. This enclosure must be able to support the following I/O density:

2.8.1.1 96 points of isolated or non-isolated discrete inputs/outputs (AC or DC)
2.8.1.2 96 points of single-ended analog inputs (4-20mA or 0-10VDC)
2.8.1.3 48 points of isolated 3 wire RTD inputs
2.8.1.4 48 points of supervisory inputs
2.8.1.5 48 points of isolated analog outputs configurable for 0-200µA, 4-20mA, 0-10VDC or -10 to 0 to 10VDC
2.8.1.6 Any combination of the above

2.8.2 A 24"x24"x8" and 24"x"24"x10" drip-proof (per NEMA 4) enclosure shall be designed with a hinged cover. Both types will include an optional removable cover. The hinged enclosure shall include a data pocket on the back of the front cover. These enclosures must be able to support the following I/O density:

2.8.2.1 96 points of isolated or non-isolated discrete inputs/outputs (AC or DC)
2.8.2.2 96 points of single-ended analog inputs (4-20mA or 0-10VDC)
2.8.2.3 48 points of isolated 3 wire RTD inputs
2.8.2.4 48 points of supervisory inputs
2.8.2.5 48 points of isolated analog outputs configurable for 0-200µA, 4-20mA, 0-10VDC or –10 to 0 to 10VDC.
2.8.2.6 Any combination of the above

2.8.3 A 30"x36"x8" drip-proof (per NEMA 4) enclosure shall be designed with a hinged cover. This design will include a version with a removable cover. The hinged enclosure shall include a data pocket on the back of the front cover. The enclosure must be able to support the following I/O density:

2.8.3.1 160 points of isolated or non-isolated discrete inputs/outputs (AC or DC)
2.8.3.2 160 points of single-ended analog inputs (4-20mA or 0-10VDC)
2.8.3.3 80 points of isolated 3 wire RTD inputs
2.8.3.4 80 points of supervisory inputs
2.8.3.5 80 points of isolated analog outputs configurable for 0-200µa, 4-20mA, 0-l0VDC or – l0 to 0 to l0VDC.
2.8.3.6 Any combination of the above

2.8.4 An industrial grade, 19" rack enclosure will be designed specifically for supervisory input signal types. The rack size shall not exceed 36U Height by 36" depth. This enclosure shall be able to support 240 supervisory signals in addition to the standard power monitoring features available from other I/O types.

2.9 Various sizes of IE enclosures are required for MCS installation onboard the CVN-68 Class vessels. All enclosures shall be capable of supporting both fiber optic and CAT-5 copper connections. Fiber optic connections shall be connected directly to a fiber optic module or to a fiber optic patch panel and terminated with military grade ST (MIL-C-83522/16B) type connections. CAT-5 copper type connections will interface with a terminal board or punch block system to provide ease of installation. Standard CAT-5 patch cords will be installed between the terminal board and the RJ-45 Ethernet switch ports on the modules.

2.10 All IE enclosures shall have a 3/16" diameter grounding stud mounted on the rear of the enclosure outside of the shock envelope which will be wired to the enclosure grounding bus. All grounding locations shall be properly cleaned of paint, coating etc. to ensure a proper bond.

2.11 All IE enclosures shall contain DIN rail mounting for field interface components such as terminal boards. All terminal boards shall be clearly labeled. Terminal boards shall not

contain exposed sharp edges. All terminal boards shall have end barriers and end clamps.

2.12   IE enclosure terminal boards will be clearly labeled with the terminal board number and fuse size (where required).

2.13   All optional IE components shall have their mounting support equipment installed even if the optional components are not installed. For example, a 24 VDC field power supply mounting kit shall be installed in each enclosure even if that enclosure does not require one.

2.14   The following IE enclosure sizes shall be supported:

2.14.1   A 24"x24"x10" submersible (per MIL-STD-108E, Notice 1) IE enclosure shall be designed with a removable cover. Two sources of power will be provided to this enclosure. The IE switches will continue operation without incident if either source is temporarily or permanently interrupted. Supported power sources must include 24VDC or I5VAC. A 5A 24VDC power supply will be included in the enclosure for use with AC supply sources. Primary and secondary sources can be any combination of AC or DC. The enclosure will contain a 3 wire mounted RTD sourced to the DIN385 or DIN392 platinum, 100 ohm curve for monitoring enclosure temperature. All components will be either finger safe or have a lexicon cover preventing accidental contact with live terminals. This enclosure must be able to support the following number of Ethernet connections:

2.14.1.1   48 CAT-5 RJ45 connections
2.14.1.2   48 Fiber ST (MIL-C-83522/16B) connections
2.14.1.3   Any combination of the above

2.14.2   A 24"x24"xl0" drip-proof (per NEMA 4) IE enclosure shall be designed with a hinged cover. The enclosure shall include a data pocket on the back of the front cover. Two sources of power will be provided to this enclosure. The IE switches will continue operation without incident if either source is temporarily or permanently interrupted. Supported power sources must include 24VDC or 115VAC. Primary and secondary sources can be any combination of AC or DC. A 5A 24VDC power supply will be included in the enclosure for use with AC supply sources. The enclosure will contain a 3 wire mounted RTD sourced to the DIN385 or DIN392 platinum, 100 ohm curve for monitoring enclosure temperature. All components will be either finger safe or have a lexicon cover preventing accidental contact with live terminals. This enclosure must be able to support the following number of Ethernet connections:

2.14.2.1   48 CAT-5 RJ45 connections
2.14.2.2   48 Fiber ST (MIL-C-83522/16B/16B) connections
2.14.2.3   Any combination of the above

2.14.3   A 16"x16"x10" submersible (per MIL-STD-108E, Notice 1) IE enclosure shall be designed with a removable cover. Two sources of power will be provided to this enclosure. The IE switches will continue operation without incident if either source is temporarily or permanently interrupted. Primary power will always be 24VDC. Secondary power can be either a second 24VDC source or 115VAC source. A 1A 24VDC power supply will be included in the enclosure for use with an AC secondary power source. The enclosure will contain a 3 wire mounted RTD sourced to the DIN385 or DIN392 platinum, 100 ohm curve for monitoring enclosure temperature. All components will be either finger safe or have a lexicon cover preventing accidental contact with live terminals. This enclosure

must be able to support the following number of Ethernet connections:

   2.14.3.1 16 CAT-5 RJ45 connections
   2.14.3.2 10 Fiber ST (MIL-C-83522/16B/16B) connections with 6 CAT-5 RJ45 connections
   2.14.3.3 Any combination of the above

2.14.4 A 16"xl16"x10" drip-proof (per NEMA 4) IE enclosure shall be designed with a hinged cover. The enclosure shall include a data pocket on the back of the front cover. Two sources of power will be provided to this enclosure. The IE switches will continue operation without incident if either source is temporarily or permanently interrupted. Primary power will always be 24VDC. Secondary power can be either a second 24VDC source or 115VAC source. A 1A 24VDC power supply will be included in the enclosure for use with an AC secondary power source. The enclosure will contain a 3 wire mounted RTD sourced to the D1N385 or DIN392 platinum, 100 ohm curve for monitoring enclosure temperature. All components will be either finger safe or have a lexicon cover preventing accidental contact with live terminals. This enclosure must be able to support the following number of Ethernet connections:

   2.14.4.1 16 CAT-5 RJ45 connections
   2.14.4.2 10 Fiber ST (MIL-C-83522/16B) connections with 6 CAT-5 RJ45 connections
   2.14.4.3 Any combination of the above

2.15 All components mounted in either the I/O or IE enclosures shall be capable of being removed and re-inserted from the front side of the enclosure. Removal of a component will not require removing the entire enclosure gland plate. Rivnuts or pre-dilled grooved installation holes are both acceptable means of accomplishing this.

2.16 All I/O and IE enclosures shall meet the various environmental requirements of MIL-STD-461E, MIL-STD-167-I, MIL-STD-108E (for enclosures designated as submersible) and MIL-S-901D.

2.17 Each enclosure shall have an attached phonemic nameplate representing the enclosure and function.

2.18 Conservation of weight shall be considered when at all possible. All components and material shall be selected using the lightest material possible yet still remain compliant to all-applicable standards and functionality.

2.19 No penetrations of hardware (e.g. screws, bolts, pins etc.) shall be made through the walls or door of an enclosure, in order to maintain its maximum watertight integrity.

2.20 Enclosures shall be designed to accept plant interface cables through watertight strain relief/stuffing tubes (MIL-S-19622F). The design must be made to facilitate connection with existing plant cables. Using information provided by the government, the contractor shall provide removable gland plates on two sides of the enclosures so they can be removed to drill holes for the stuffing tubes.

2.21 All internal enclosure wiring terminations will require the use of tinning or ferrules. No more than 2 wires shall be combined into one ferrule. Cutting off strands of copper to reduce size of lead to fit ferrule is prohibited.

2.22 Pre-fabricated, metal jumper strips shall be used where multiple (i.e. greater than 2) terminations are required.

2.23   All internal enclosure wiring, with the exception of jumper wires shorter than 4", shall be properly labeled with "to/from" information (e.g. TB0-12/TB3-8) on heat shrinkable, non-smearing, oil-resistant wire markers as per MIL-I-23053.

2.24   All internal enclosure wiring will be low smoke and meet the requirements of MIL-W-81044. Only non-PVC wire shall be used within an enclosure.

2.25   All internal enclosure wiring shall adhere to the following requirements:

    2.25.1   All DC circuits up to 2A shall use 20AWG wire
    2.25.2   All AC circuits up to 2A shall use I8AWG wire
    2.25.3   All AC circuits greater than 2A shall use I 6AWG wire
    2.25.4   All grounds shall use I4AWG wire

2.26   All enclosure fuse ratings shall adhere to the following requirements:

    2.26.1   All primary and secondary 120VAC power sources into an enclosure shall use 4A slow blow fuses
    2.26.2   All 120VAC input signals shall use 1A fast acting fuses
    2.26.3   All 120VAC output signals shall use 2A fast acting fuses
    2.26.4   All JP5 service pump 120VAC output signals shall use 6A fast acting fuses
    2.26.5   All 24VDC input signals shall use 1A fast acting fuses
    2.26.6   All 24VDC output signals shall use 2A fast acting fuses
    2.26.7   All 4-20mA signals shall use 0.5A fast acting fuses
    2.26.8   All 24VDC power sources into an IE enclosure shall use 4A slow blow fuses
    2.26.9   All RTD signals shall NOT be fused

2.27   All enclosure types (i.e. enclosures and racks, drip proof and submersible) shall require keyed locking devices to secure entry. No penetrations shall be made through an enclosure that compromise its watertight integrity. It is preferable that the locking device be integral with the enclosure. However, if necessary, and as approved by the government agency, additional mounting brackets, clasps, hardware can be fitted to an enclosure to accommodate the security devices.

2.28   All internal enclosure wire termination, routing, splicing, banding, securing and other electrical/electronic enclosure techniques shall conform to the standards of Electronic Installation and Maintenance Book (EIMB), NAVSEA 0967-LP-000-0110

2.29   All enclosures shall provide for an EMI power line filter for all AC input power sources. The EMI power line filter shall meet all applicable military specification, as stated in Paragraph 6.

2.30   All hardware of the I/O and IE enclosures shall be capable of operating at an ambient temperature of 0 to 55^0C (32 to I 30^0F), with an ambient temperature rating for storage of -40 to $+85^0$C (-40 to $+185^0$F).

3. PLC ENCLOSURE COMPONENTS

3.1.   Reliability. The mean time between failure (MTBF) shall be a minimum of 20,000 operating hours. All components of the PLC system shall require maintenance not more frequently than annually.

3.2.   Duty. The PLC shall be constructed to operate for continuous duty and general-purpose service as specified in MIL-C-2212.

3.3.   Diagnostics. The PLC system shall have resource and diagnostic control at all system levels. The PLC system shall provide diagnostics capabilities to allow troubleshooting down to the lowest replaceable unit. Diagnostics shall be of power up and on-line type. The PLC shall be capable of supporting a device that will display diagnostic results, status of selectable addresses, and the suspected modules that could cause the failure. The elimination of suspected failed modules shall be a maximum of three of the most likely modules that could cause that particular failure.

3.4.   Logic function. The internal wiring of the controller shall be fixed, and all logic functions that shall be performed in a given application shall be programmed into its memory.

3.5.   Serial port. The PLC shall have one dedicated serial port that supports Electronic Industries Alliance (EIA) 232 signals. It shall be accessible in control logic and provide support for Master and Slave SCADA communication protocol systems. Alternatively, it shall be usable for programming purposes or for access to peripheral devices such as bar code scanners, CRTs, etc.

3.6.   Electrical service. The PLC shall operate in compliance with an electrical service of either 120 VAC, single phase, in the frequency range from 47 to 63 Hz, or 24 VDC.

3.7.   Cooling. All system modules, main and expansion chassis shall provide free airflow convection cooling. No internal fans or other means of cooling, except heat sinks, shall be permitted.

3.8.   Central processing unit.

     3.8.1.   Function. The PLC Central Processing Unit (CPU) shall be a self-contained unit and shall provide control program execution, I/O scanning and support remote or local programming.

     3.8.2.   Discrete and analog points. The processor shall be capable of addressing a minimum of 10,000 discrete points or 1,000 analog points. Processor shall be capable of communicating with 50 physical locations each containing I/O as a minimum

     3.8.3.   Multiple independent, asynchronous scans. The PLC processor shall use designated scans for processing of input and output information, program logic, and background processing of other processor functions. Input and output devices located in the same backplane (local I/O) as the CPU shall produce at the rate of the configured Requested Packet Interval (RPI), and for inputs enabled for Change of State (COS), at the time any point changes state. Scan rates for devices located in backplanes other than that in which the processor is located shall be user selectable and shall range from 2 to 100 milliseconds (ins).

     3.8.4.   Features. The processor shall contain the following performance features as a minimum:

       3.8.4.1   16K user memory words capability.

       3.8.4.2   Ladder logic, Sequential Function Chart (SFC), and structured-text programming support compliant with the IEC 61131-3 standard.

       3.8.4.3.   Configurable EIA 232 port for programming.

       3.8.4.4.   Advanced instruction set including file handling, sequencer, diagnostic, shift register, immediate-I/O, and program control instructions.

       3.8.4.5.   Multiple main control programs for segregation of control tasks.

       3.8.4.6.   Processor input interrupts and global status flags.

       3.8.4.7.   Programmable fault response for reacting to a fault before the system goes down.

       3.8.4.8.   Timed-interrupt routine for examining specific information at specific time intervals.

3.8.5.   Removable programmable devices. The operating system and application specific program files shall be contained in removable programmable devices that allow for easy field replacement.

3.8.6.   Fault indication. The CPU shall perform internal diagnostic checks and give visual indication to the user by illuminating a "green" indicator when no fault is detected and a "red" indicator when a fault is detected as specified.

3.8.7.   Data bits. The CPU shall be capable of addressing at least 48,000 words comprised of 16 data bits.

3.8.8.   User program. The user programs and data shall be contained in non-volatile memory.

3.8.9.   Firmware. The operating system shall be contained in non-volatile firmware.

3.8.10. Memory. The controller shall contain no less then 100 kilobytes of base memory. It shall provide the capability to increase the memory up to at least 2 megabytes.

3.8.11. Mode selector switch. The processor mode shall be selectable by a key switch mounted on the front panel of the CPU. The key switch shall allow the selection of the following modes:

       3.8.11.1. RUN - No control logic edits possible, program always executing.

       3.8.11.2. PROGRAM - Programming allowed, program execution disabled.

       3.8.11.3. REMOTE - Programming terminal can make edits and change processor mode, including TEST mode, whereby the logic executes and inputs are monitored, but edits are not permanently active unless assembled.

3.8.12. Processor fault. The PLC shall provide a visual indication of a PLC processor fault. By default, a PLC processor fault shall cause analog control signals to fail in the last state and digital control signals to fail in the low state. The PLC shall have the capability for the discrete output signals to fail to its last known state. The PLC shall provide the capability to change the analog and digital control signal state in response to a failure. If the fault is caused by a memory problem, it shall be possible to clear the fault using a procedure to boot the PLC from the EEPROM or FLASHPROM memory. The devices associated with the control signals shall remain in the last state, with the exception of signals that require a continuous output voltage.

3.8.13. Power loss. A total loss of 120 VAC supplying the PLC shall cause the PLC

system to shutdown. All control signals associated with that PLC shall fail in the low state. Loss of 24-VDC PLC power supply shall prevent commands associated with that PLC from being energized. Status change signals that do not have alarms associated with them shall display the open state of the digital contact. Control signals that rely on 24-VDC power from the PLC cabinet shall fail to energize.

3.8.14. Input and output devices. Input and output devices located in the same backplane (local I/O) as the CPU shall be capable of being scanned synchronously in under 0.5 ms. Concurrent with this I/O update time, the processing of a typical logic program shall not exceed 0.5 to 2 ms for 1024 instructions with a maximum overhead of 4.5 ms.

3.8.15. Remote input and output devices. Input and output devices located remotely should be capable of being scanned in under 10 ms for a 57.6-kilobyte/sec transfer rate, under 7 ms for a 115.2-kilobyte/sec transfer rate, and under 3 ms for a 230.4-kilobyte/sec transfer rate.

3.9. Chassis. The I/O chassis shall be capable of holding the CPU, communication modules and I/O modules. The chassis size shall be a minimum of 5 incremental sizes ranging between 4 and 20 module slots.

3.9.1. Indicators. The following indicators and status information shall be shown on the chassis or modules within the chassis:

3.9.1.1. PROGRAM or RUN mode of the CPU.
3.9.1.2. The RUN/FAULT status of the CPU.
3.9.1.3. ENABLED/DISABLED state of outputs.
3.9.1.4. State of the I/O adapters.
3.9.1.5. Data I/O forces PRESENT/ACTIVE.
3.9.1.6. Remote device communicating via the inter-processor communications link.
3.9.1.7. Status of the Ethernet transceiver port.
3.9.1.8. Data transfer activity over the Ethernet.
3.9.1.9. EIA 232 activity.

3.9.2. Mounting and construction. The PLC chassis shall be capable of being back stud mounted to an enclosure panel without the need for an external bracket.

3.9.3. Internal power distribution. In a single chassis, all system and signal power to the CPU and support modules shall be distributed on a single motherboard or back plane with no interconnecting wiring between these modules via plug-term mated jumpers.

3.9.4. Removable modules. All system modules shall have the option of being removed from the chassis or inserted into the chassis while power is being supplied to the chassis without faulting the processor or damaging the modules.

3.9.5. PLC modules. PLC modules shall plug and lock into the PLC chassis.

3.9.6. Key ways. Modules shall be keyed to allow installation in predetermined slots and proper direction.

3.9.7. Self-contained unit. Each module shall be a self-contained unit housed within an enclosure.

3.9.8. <u>Analog and discrete signals</u> . The PLC system shall be capable of addressing a minimum of 1,000 analog or 10,000 discrete signals necessary to interface with the shipboard system(s). The PLC system shall be able to interface with the following signal types:

3.9.8.1. Analog Input:
3.9.8.1.1 - 10 to 10VDC
3.9.8.1.2. 0 to 160 VAC (60 Hz)
3.9.8.1.3. 4 to 20 mA
3.9.8.1.4. ±20 mA
3.9.8.1.5. 0 to 5 A (60 Hz)
3.9.8.1.6. Tachometer
3.9.8.1.7. RTD
3.9.8.1.8. Thermocouple

3.9.8.2. Analog Output:
3.9.8.2.1. -10 to 10VDC
3.9.8.2.2. 4 to 20 mA
3.9.8.2.3. ± 20 mA

3.9.8.3. Digital Input:
3.9.8.3.1. 115 VAC Discrete Inputs (Isolated and Non-Isolated)
3.9.8.3.2. 24 VDC Discrete Input (Non-Isolated, Normally Open or Normally Closed)
3.9.8.3.3. Supervisory Contact Input (Normally Open or Normally Closed)
3.9.8.3.4. VDC Discrete Input (Non-Isolated)

3.9.8.4. Digital Output:
3.9.8.4.1. 115 VAC Discrete Output (Maintained or Momentary)
3.9.8.4.2. 24 VDC Discrete Output (Maintained or Momentary)
3.9.8.4.3. 28 VDC Discrete Output (Maintained or Momentary)
3.9.8.4.4. Normally Open Contact (Isolated or Non-Isolated)
3.9.8.4.5. Normally Closed Contact. (Isolated or Non-Isolated)

3.9.9. <u>I/O modules types</u>. The following types of I/O modules shall be available for use in the PLC chassis:

3.9.9.1. 16-channel (minimum) 10-to 30-VDC Digital Input Module capable of being selectable to reset or hold last state during a fault.
3.9.9.2. 16-channel (minimum) 0- to 30-VDC Diagnostic Discrete Input Module. The card shall be able to detect a wire break versus an open contact.
3.9.9.3. 6-channel (minimum) 16-bit RTD Input Module capable of reporting degrees Celsius (^{0}C), degrees Fahrenheit (^{0}F), or current for 100-ohm platinum multiple curves including 385 and 392, 120-ohm nickel multiple curves including 672 and 618 curve, or 10-ohm copper sensors.
3.9.9.4. 6-channel (minimum) 16-bit Thermocouple Input Module capable of interfacing with type B, C, E, J, K, N, R, S, and T thermocouples.
3.9.9.5. 16-channel (minimum) 12-bit Analog Input Module capable of 0 to 5 VDC, ±5 VDC, ±10 VDC, 4-20 mA, 0-20 mA, ±20 mA. The card shall contain 8 differential inputs or 16 single ended inputs. The card shall provide binary or binary-coded decimal (BCD) scaling.
3.9.9.6. 6-channel (minimum) isolated 12-bit Analog Output Module capable of 0-5 VDC, ±5 VDC, ±10 VDC, 4-20 mA, 0-20 mA, ±20 mA. The card shall contain 8 differential outputs with 1000-volt insulation. The card

shall provide binary or BCD scaling.

3.9.9.7. 16-channel (minimum) 24 to 250 VAC individually isolated Contact Output Module. A minimum of 8 contact outputs shall be selectable between normally open and normally closed.

3.9.9.8. 16-channel (minimum) 10- to 30-VDC Digital Output Module.

3.9.9.9. 16-channel (minimum) 30- to 60-VDC Digital Output Module.

3.9.9.10. A module capable of high speed power system monitoring, power system synchronization and load sharing. The module shall be capable of measuring voltage and current from the two three-phase systems and provide control and error signals to implement automatic governor control and synchronization. The module shall generate breaker closure commands within specified windows. Power transducers shall be included in the PLC system.

3.9.9.11. 16-channel (minimum) 30- to 55-VDC Digital Input Module.

3.9.9.12. 16-channel (minimum) 30- to 55-VDC Diagnostic Digital Input Module. The module should be able to detect a wire loss.

3.9.9.13. 16-channel (minimum) 10- to 30-VAC Digital Input Module.

3.9.9.14. 16-channel (minimum) 10- to 30-VAC Diagnostic Digital Input Module. The module should be able to detect a wire loss.

3.9.9.15. 16-channel (minimum) 79- to 132-VAC Digital Input Module.

3.9.9.16. 16-channel (minimum) 79- to 132-VAC Diagnostic Digital Input Module. The module should be able to detect a wire loss.

3.9.9.17. 16-channel (minimum) 10- to 30-VAC Digital Input Module.

3.9.9.18. 16-channel (minimum) 10- to 30-VAC Diagnostic Digital Output Module. The module should be able to detect loss of load or output power.

3.9.9.19. 16-channel (minimum) 79- to 132-VAC Digital Output Module.

3.9.9.20. 16-channel (minimum) 79- to 132-VAC Diagnostic Digital Output Module. The module should be able to detect loss of load or output power.

3.9.9.21. 16-channel (minimum) 10- to 30-VDC Diagnostic Digital Output Module. The module should be able to detect loss of load or output power.

3.9.9.22. 16-channel (minimum) 30- to 60-VDC Diagnostic Digital Output Module. The module should be able to detect loss of load or output power.

3.9.9.23. 6-Channel (minimum) Analog Current Output Module with a scalable output range of 0 to 21 ma. Each channel must be isolated with 1000 Volt or better isolation between channels.

3.9.9.24. 6-Channel (minimum) Analog Voltage Output Module with a scalable output range of -10.5 to 10.5 VDC. Each channel must be isolated with 1000 Volt or better isolation between channels

3.9.10. <u>High resolution analog input module</u>. The High Resolution Analog Input Module shall perform analog to digital conversions to directly interface analog signals to PLC data table values using a minimum of 16-bit resolution. Analog Input must be capable of being user-configured for the desired fault-response state in the event that I/O communication is disrupted. This feature shall provide a safe reaction/response in case of a fault, limit the extent of faults, and provide a predictable fault response. This module shall provide high (minimum of 1,000 volts) isolation between channels.

3.9.10.1. Minimum of 6 independent channels available.

3.9.10.2. Minimum channel update/resolution shall be 18ms/6 channels, 36ms/16 channels, and at least 16-bit resolution.

3.9.10.3. An analog module status block to provide information to the processor for alarming and troubleshooting.

3.9.10.4. User-configurable output response (min, max, mid-range, or last value) for safe reaction to an analog module fault.

3.9.10.5. Analog module software-selectable features to include digital filtering for noisy transmitters and environments, and range selection per input.

3.9.10.6. Module shall be configurable for multiple ranges including 0-10 VDC, 0-20 ma, -10 to 10 VDC. Configuring a channel for current or voltage shall be accomplished in software and will not require the use of dip switches or miniature hardware jumpers on the module.

3.9.11. <u>Analog alarm</u>. Alarm indication for each analog signal shall be determined on a point-by-point basis. As a minimum, each analog signal shall have an out-of-range high and out-of-range low alarm indication (see 6.3.1 and 6.3.2). Alarm indications shall have a reset requirement. Alarm indications shall have the option of an automatic reset. The analog signal shall have only one current alarm indication such that only one alarm type shall be active for a particular signal. The hierarchy shall be as follows: Warn high shall be cleared upon receiving a high alarm; high alarm shall be cleared upon receiving an out-of-range high; Warn low shall be cleared upon receiving a low alarm; low alarm shall be cleared upon receiving an out of range low. High and low alarm indications shall be mutually exclusive, such that the active alarm is the only current alarm indication.

3.9.12. <u>Analog signal status</u>. The following status shall be programmable for each analog signal.

3.9.12.1. Out-of-Range High.

3.9.12.2. Alarm High.

3.9.12.3. Warn High.

3.9.12.4. Normal.

3.9.12.5. Unknown.

3.9.12.6. Warn Low.

3.9.12.7. Alarm Low.

3.9.12.8. Out-of-Range Low.

3.9.12.9. Out-of-Service.

3.9.13. <u>Digital alarms</u>. The PLC shall be capable of supporting two (2) types of digital alarms. The first type of alarms are those determined from discrete digital input signals. Digital inputs for these types of alarms shall be fail-safe. The digital input is defined as normally open or normally closed. However, the alarm state of the contact shall be defined in such a way to cause the input contact to open when an alarm condition occurs. The second types of digital alarms are those generated by PLC logic. These types of alarms are for device level alarm indications, such as valves, pumps and diesels, and for command failures. Alarms shall be identified for each discrete digital point in each PLC.

3.10. <u>Communication</u>. The PLC system shall have the ability to support several communications options for processor-to-processor, processor to remotely located I/O racks, and processor to human machine interface (HMI) communications with a maximum of one card per communication network. BOOTP client capability shall be provided in the PLC processor to allow assignment of an IP address upon power up. The option shall be selectable on or off.

3.10.1. <u>Communication protocol types</u>. The PLC system shall be capable of supporting token passing and (carrier sense multiple access/collision detection) CSMA/CD Ethernet protocols as specified in IEEE 802.3.

3.10.2. <u>Network media</u>. The PLC system shall enable all communications to be accomplished through copper or fiber optic media.

3.10.3. <u>Network topologies</u>. PLC system networks shall support star, bus, ring and/or a

combination thereof.

3.10.4. <u>General network capabilities</u> . All PLC system network communications shall contain the following performance features:

   3.10.4.1. Message error checking.
   3.10.4.2. Retries of unacknowledged messages.
   3.10.4.3. Diagnostic checks on other stations.
   3.10.4.4. Interface with more than one network.
   3.10.4.5. Ability to perform PLC processor memory uploads and downloads.
   3.10.4.6. Bi-directional communication between programmable controllers and communication networks via a standard modem interface. The communication protocol(s) shall meet EIA 232 or ANSI standard communication protocol requirements.
   3.10.4.7. Ability to communicate with all other models of PLCs manufactured by the same supplier.
   3.10.4.8. Ability to monitor the status of any processor remotely via the network.

3.10.5. <u>Loss of</u> <u>communications</u>. During the loss of communications, individual PLCs shall continue to run and remain in a safe state of control. Loss of communication between PLCs shall cause signals to remain in their last known state in the PLC that requires the information. Control signals shall fail in a de-energized state.

3.10.6. <u>PLC processor-to-PLC processor (peer-to-peer) communications</u>. PLC processors shall have the ability to send and receive data from other PLC processors through Ethernet and other network protocols.

3.10.7. <u>PLC processor to remote I/O rack communications</u>. PLC processors shall have the ability to send and receive data from remote I/O racks via Ethernet and other network protocols.

3.10.8. <u>PLC processor to human machine interface (HMI) communications</u>. The PLC processor shall be capable of transferring data to and from HMI application software via Ethernet TCP/IP, UDP, IP multicast, or OPC.

3.10.9. <u>OLE for process control (OPC)</u>. Data communications using OPC shall be accomplished using an external OPC server software application, using the PLC processor itself as an OPC server or having a module within the PLC rack that contains an OPC server.

3.10.10. <u>UDP broadcast data</u> . The PLC processor shall be capable of sending data on a network using UDP or IP multicast protocols.

3.10.11. <u>TCP/IP protocol</u>. The PLC processor shall be capable of sending and receiving data on a network using the TCP/IP protocol. Communication with HMI devices shall require no intermediate external software applications.

3.10.12. <u>Ethernet</u>. The PLC system shall provide industry standard Ethernet communication capabilities embedded either in the PLC processor or through an Ethernet communication module.

   3.10.12.1. General Ethernet capabilities. The Ethernet interface shall support the following:
      3.10.12.1.1. Standard IP communications.
      3.10.12.1.2. Standard Ethernet media (10base2, 10base5, 10/100baseT, 10/100baseF).

3.10.12.1.3. CSMA/CD access method.

3.10.12.1.4. Subnet masking in order to comply with networks that use subnetting.

3.10.12.1.5. Standard repeaters, bridges, routers, host computers, peer PLCs.

3.10.12.1.6. RJ-45 and AUI ports.

3.10.12.1.7. BOOTP client (selectably turned on or off).

3.10.12.1.8. Bridging to other types of networks (e.g. ControlNet and Profibus).

3.10.12.1.9. Support both scheduled and unscheduled messaging simultaneously on the same Ethernet cable.

3.10.12.2. <u>Network connection</u>. The PLC processor shall have a selectable option of using IEEE 802.3 as the interface to the network as well as DIX.

3.10.12.3. <u>Ethernet diagnostic status</u> . The programmable controller shall maintain locally an Ethernet diagnostic status file that contains relative counters to record the number of retries.

3.10.12.4. <u>Token passing network</u>. The PLC system shall provide an industry standard token passing network option with the following minimum capabilities:

3.10.12.4.1. Support a data transfer rate of at least 5 megabit/sec.

3.10.12.4.2. Support at least 48 addressable nodes without a repeater.

3.10.12.4.3. Support the use of repeaters to extend the number of addressable nodes.

3.10.12.4.4. Support both scheduled and unscheduled messaging simultaneously on the same cable.

3.10.12.4.5. Support update times of at least 100 ms.

3.10.12.4.6. Support multiple network media and topologies.

3.11. <u>Power supply</u>. The system power supply shall be capable of converting 120 VAC line power to the DC power required to operate the programmable controller backplane, CPU, and modules. The power supply shall operate with 97 to 132 VAC, single phase, from 47 to 63 Hz or 19 to 32 VDC.

3.11.1. <u>Power up</u>. Operation of the processor and I/O modules shall be inhibited during power up until DC values are within specified limits.

3.11.2. <u>Power shut down</u>. Power supply shall automatically shut down the PLC system when the output current exceeds 125% of rated current. If the voltage level is out of range for more than ½ cycle, the power supply shall automatically shut down the system and remain shut down until the voltage returns to the proper level. The power supply shall provide surge protection, isolation, and outage carryover up to 2 cycles of the AC line.

3.11.3. <u>Diagnostic indicators</u>. The PLC power supply shall include diagnostic indicators mounted in a position easily viewed by the user. These indicators shall provide the operator with the status of the DC power applied.

3.11.4. <u>Main power supply</u> . A single main power supply shall have the capability of supplying power to the CPU and local I/O modules. Auxiliary power supplies shall provide power to remotely located racks.

3.11.5. <u>Constant voltage transformer</u>. In cases where the AC line is especially unstable or

subject to unusual variations, it shall be possible to install a constant voltage transformer having a sinusoidal output waveform.

3.11.6. <u>Insulating cover</u>. An insulating cover shall be mounted over high voltage terminals to provide protection for maintenance personnel and allow for easy removal.

3.11.7. <u>Fuse protection</u>. The power supply shall have adequate fuse protection to prevent damage to the power supply in the event of overcurrent.

3.11.8. <u>Fluctuation</u>. The power supply shall not fluctuate for loads between 1 and 10 amps.

3.11.9. <u>Auxiliary power supply</u>. The auxiliary power supply shall include provisions for remote sensing and/or external output adjustment, and shall be short circuit proof with automatic recovery (electronic current limiting). Response time shall be less than 20 microseconds.

3.12. <u>Terminal boards</u>.

3.12.1. <u>EC type</u>. EC type terminal boards shall be provided for field wire connections.

3.12.2. <u>Location</u>. The terminal boards shall be located near the cable entrance.

3.12.3. <u>Accessibility</u>. Terminal boards shall be accessible from the front of the enclosure.

3.12.4. <u>Identification</u>. All terminal boards shall be organized and marked to establish easy identification of signals.

3.12.5. <u>Fused terminal blocks</u>. Fused terminal boards shall be provided for 4 to 20 mA transmitters, discrete input, and discrete output signals.

3.13. <u>Program creation and storage</u>.

3.13.1. <u>Control logic programs</u>. Control logic programs shall provide for immediate access to the sub-elements of control structures by address and sub-element mnemonic, such as timer accumulator value, timer done bit, or PID process variable value.

3.13.2. <u>Non-volatile memory</u>. The operating system information shall be stores in non-volatile memory to protect against loss in the case of power loss or system shutdown.

3.13.3. <u>Program storage medium</u>. The program storage medium shall be of a static RAM type. The RAM shall have the capability of being backed up by a battery.

3.13.4. <u>Memory</u>. Memory shall be available in 48K word segments of RAM memory.

3.13.5. <u>Access method</u>. The access method to the media shall be Carrier Sense with Multiple Access and Collision Detection (CSMA/CD).

3.13.6. <u>System power</u>. The capability shall exist to remove all batteries from the system without removing system power.

3.13.7. <u>Non-volatile memory</u>. The PLC processor shall provide the use of a removable non-volatile memory such as EEPROM or FLASHPROM as a back up for volatile memory up to the full capacity of the controller. The memory card shall have a

capacity of at least 64MB.

3.13.8. <u>Memory back-up</u>. The capability to back-up volatile memory, including data and program logic shall be provided.

3.13.9. <u>Upgradeable processor memory</u>. The capability to upgrade to a processor memory with a larger size simply by saving a program, replacing the processor, and downloading the program to the new system without having to make any program changes shall be provided.

3.13.10. <u>User memory</u>. All user memory in the processor not used for program storage shall be allocable from main memory for the purpose of data storage. The programmable controller system shall be capable of storing predefined, user-defined and module-defined data types.

    3.13.10.1.   Boolean values.
    3.13.10.2.   Control structure.
    3.13.10.3.   Counter values.
    3.13.10.4.   Integer values.
    3.13.10.5.   Message values.
    3.13.10.6.   Real numbers.
    3.13.10.7.   Signed integer numbers.
    3.13.10.8.   Timer values.
    3.13.10.9.   External output status.
    3.13.10.10. External input status.
    3.13.10.11. Floating point numbers.
    3.13.10.12. Decimal numbers.
    3.13.10.13. Binary numbers.
    3.13.10.14. BCD numbers.
    3.13.10.15. Direct and indexed addressing.
    3.13.10.16. Internal processor status information.
    3.13.10.17. ASCII character data.
    3.13.10.18. ASCII string data.
    3.13.10.19. Data transfer control structures.
    3.13.10.20. File instruction control structures.
    3.13.10.21. Message control structures.

3.13.11. <u>Access to sub elements</u>. Control logic programs shall have immediate access to the sub elements of control structures by address and sub element mnemonic, such as timer accumulator value, timer done bit, or PID Process Variable value.

3.13.12. <u>Timer programming</u>. The number of times a timer or counter can be programmed shall be limited only by the memory capacity to store these instructions.

3.13.13. <u>Internal output programming</u>. The number of times a normally open (NO) and/or normally closed (NC) contact of an internal output can be programmed shall be limited only by the memory capacity to store these instructions.

3.13.14. <u>Application logic</u>. The capability shall be provided to program select application logic more than once into memory.

3.13.15. <u>Contacts and rungs</u>. If contacts or entire rungs are intentionally deleted from an existing logic program, the remaining program shall be automatically repositioned to fill this void. Whenever contacts or entire rungs are intentionally

inserted into an existing program, the original program shall automatically be repositioned to accommodate the enlarged program. All rungs shall maintain their original links.

3.13.16. Base processor memory. Base processor memory shall be provided for user program and data.

3.13.17. Module-defined data. Module-defined data types shall include a structure for each I/O module and system or module specific information (hidden from user). Any data can be displayed in Binary, Octal, Hexadecimal, or Decimal radices.

3.13.18. User-defined data. User-defined data types shall include user-defined structures capable of containing one or more pre-defined data members.

3.13.19. Application program interface. Application Program Interface (API) shall be offered for Windows operating systems in the form of linkable libraries for C application programs.

3.13.20. Task programs. Each task can include up to 32 programs that are capable of being ordered for execution in each task.

3.13.21. On-line programming. On-line programming and upload/downloads of control programs shall be capable of occurring over the Ethernet network.

3.13.22. Programming terminal. The programming terminal shall be connected either directly to the PLC processor or via the Ethernet interface.

3.13.23. Software and licenses. Software and licenses shall be provided to interface the Windows based processor HMI program with the PLC processors.

3.13.24. Sub-system. The programmable controller sub-system shall have the ability to be updated electronically to interface with new modules

3.13.25. Programming format. The programming format shall be IEC 61131-3 compliant for Instruction List, Structured Text, Ladder Diagram and Function Block Diagram.

3.13.26. Sequential function chart and structured text operations. Sequential function chart and structured text operations shall execute in the CPU in native op codes. Representative ladder logic shall not be generated for corresponding sequential function chart and structured text operations.

3.13.27. Maximum instruction matrix. It shall be possible to program a maximum instruction matrix of 7 wide by 6 deep containing as many as 77 examine instructions.

3.13.28. Periodic tasks. Periodic tasks shall run via an interrupt at a user-defined interval in one-millisecond increments to a maximum of 2000 seconds. The periodic tasks shall have an associated, user assignable priority from one to fifteen (one being the highest priority), which specifies that task's relative execution priority in the multitasking hierarchy.

3.13.29. Interrupt mechanism. The interrupt mechanism of periodic tasks shall adhere to the IEC 61131-3 definition of pre-emptive multitasking.

3.13.30. Number of individual tasks. The controller shall be able to accommodate 32

individual tasks of which a minimum of one shall be continuous.

3.13.31.   Watchdog timeout. Each task shall have a watchdog timeout that is unique to that task and user-defined.

3.13.32.   Ladder logic routines. Each program shall include user ladder logic routines of which a minimum of one shall be specified in the main routine and at least one shall be specified as the fault routine. The maximum number of routines contained in a program shall be limited only by memory.

3.13.33.   Programming. It shall be possible to program ladder rungs with the following restrictions. Within a single ladder routine series instruction count limited only by user memory, branch extensions limited only by user memory, branch nesting to 6 levels or more.

3.13.34.   Contact editing. The capability shall exist to change the state of a contact from normally open to normally closed, add instructions, and change addresses, without deleting and reprogramming the entire rung.

3.13.35.   Deletion commands. A single program command or instruction shall enable deletion of an individual ladder diagram rung from memory, without deleting the rung contact by contact.

3.13.36.   Deletion safeguard. A two-part command shall be used to delete all relay ladder rungs from memory, providing a safeguard wherein the operator must verify their intentions before erasing the entire program.

3.13.37.   Rung comments. The system shall have the capability to enter rung comments above ladder logic rungs. The capability shall be provided to enter comments at the same time the ladder logic is entered.

3.13.38.   Rung editing. The capability shall exist for adding, removing, or modifying ladder logic rungs during program execution. When changes to ladder logic are made or new logic rungs are added, it shall be possible to test the edits of such rungs before removal of the prior logic rung is executed.

   3.13.38.1.   Relay ladder logic rungs. It shall be possible to insert relay ladder logic rungs anywhere in the program even between existing rungs.

   3.13.38.2.   Ladder logic editing. The PLC System shall have the capability to remove an entire logic rung into an edit buffer where individual parameters may be easily altered.

3.13.39.   Controller variables. Variables within the controller shall be referenced as unique, default, or user defined tags.

3.13.40.   Tags. The ability to program control logic via tags of the programmable controller shall exist. Tags shall be created off-line, on-line in program mode, and at the same time the ladder logic is entered.

   3.13.40.1.   Availability. Tags shall be available to all tasks in the controller (controller scoped) or limited in scope to the routines within a single program (program scoped) as defined by the user.

   3.13.40.2.   Alias. Any tag shall have the ability to be aliased by another tag that is defined and has meaning to the user.

3.13.40.3. <u>Tag naming convention</u>. Tag naming convention shall adhere to IEC 61131-2.

3.13.40.4. <u>Description</u>. The system shall have the capability to store a description for each tag.

3.13.41. <u>User-defined data structures</u>. The capability shall exist to organize data in the form of User-Defined Data Structures. All aforementioned data types, as well as others, shall be used in such structures along with embedded arrays and other User-Defined Data Structures.

3.13.42. <u>Array configuration</u>. Arrays shall be configurable with one, two, or three dimensions.

3.13.42.1. <u>Value arrays</u>. Value arrays shall be limited in size only by the amount of available memory.

3.13.42.2. <u>Addressing index</u>. The CPU shall support indexed addressing of array elements.

3.13.42.3. <u>Array element manipulation instructions</u>. Array element manipulation instructions such as high speed "array copy" and "array fill", "array to array" move, "element to array" move, "array to element" move and "first in - first out" shall be supported by the system. The four-function math instructions and instructions for performing "logical OR", "logical AND", "exclusive OR", and comparison instructions such as "less than", "greater than", and "equal to" shall be included within the system. All instructions shall execute on either single words or arrays.

3.13.43. <u>Status of channels</u>. For any module specifically associated with the programmable controller, it shall be possible to query the current status of all channels through controller-scoped tags without any programming.

3.13.44. <u>Master system clock</u>. The programmable controller shall provide a master system clock that shall allow synchronization of all axes in the chassis local to the controller.

3.13.45. <u>User applications</u>. The controller shall organize user applications as tasks that can be specified as continuous or periodic.

3.13.46. <u>Clock/calendar</u>. A clock/calendar feature shall be included within the CPU with access from the programming terminal, user program, or message generation.

3.13.47. <u>Latch functions</u>. Latch functions shall be internal and programmable.

3.13.48. <u>Software timers and counters</u>. The system shall have the capability to address software timers and software counters in any combination and quantity up to the limit of available memory. The CPU shall handle all management of these instructions into memory. Instructions shall permit programming timers in the on or off delay modes. Timer programming shall also include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment and down-increment.

3.13.49. <u>Timer instructions</u>. Timer instructions shall include selectable time bases in

increments of 1 second, 10 ms, and 1 ms with at least 10 ms accuracy. The timing range of each timer shall be from 0 to 2,147,483,648 increments. It shall be possible to program and display separately the timer's preset and accumulated values.

3.13.50.   Signed integer format. The PLC processor shall use a double integer format ranging from -2,147,483,648 to +2,147,483,647 for data storage of the counter preset and accumulated values.

3.13.51.   Data storage. The PLC processor shall store data in the following formats:

  3.13.51.1.   Boolean Values (0 or 1).

  3.13.51.2.   Short Integer Numbers ranging from -128 to +127.

  3.13.51.3.   Signed Integer Numbers ranging from -32,768 to +32,767.

  3.13.51.4.   Double Integer Numbers ranging from -2,147,483,648 to +2,147,483,647.

  3.13.51.5.   Floating Point Numbers consisting of eight significant digits. For numbers larger than eight digits, the CPU shall convert the number into exponential form with a range of ± 1.175494 E -38 to ± 3.402824 E +38.

  3.13.51.6.   Decimal Numbers ranging from 0 to 9,999.

3.13.52.   Math functions. The processor shall have support for integer and floating point signed math functions consisting of addition, subtraction, multiplication, division, and square root.

3.13.53.   Multiple channels. When using modules such as analog where multiple channels are terminated on one module, it shall be possible to transfer the current status of all channels to the CPU upon execution of one program instruction. This instruction shall be bi-directional to include data transfer from the CPU to the module or from the module to the CPU.

3.13.54.   Grouping contiguous 16-bit data words. Instructions shall be provided for grouping contiguous 16-bit data words into a file. The system shall address up to 1,000 files with up to 1,000 words per file. File manipulation instructions such as high-speed "file copy" and "file fill", "file to file" move, "element to file" move, "file to element" move, and "first in - first out" shall be supported by the system. The four function math instructions and instructions for performing "logical OR", "logical AND", "exclusive OR", and comparison instructions such as "less than","greater than", and "equal to" shall be included within the system. All instructions shall execute on either single words or files.

3.13.55.   Asynchronous and synchronous. The processor shall contain instructions, which shall construct asynchronous and synchronous 16-bit word shift registers. Additional instructions shall be provided to construct synchronous bit shift registers.

3.13.56.   Jump instruction. The processor shall have a jump instruction that shall allow the programmer to jump over portions of the user program to a portion marked by a matching label instruction.

3.13.57.   Management of all data types. The CPU shall automatically manage all data types. For example, if a word stored in the integer section of memory is transferred into the floating-point section, the CPU shall convert the integer value into floating-point prior to executing the transfer.

3.13.58.   Subroutine section. In applications requiring repeatable logic rungs, the capability shall exist to place such rungs in a subroutine section. Instructions, which call the subroutine and return to the main program, shall be included within the system. The capability shall exist to program several subroutines and define each subroutine by a unique program file designator. The processor shall support nesting of subroutines a minimum of seven levels deep. The program format as displayed on the CRT/LCD shall clearly define the main program and all subroutines. The capability shall exist to pass selected values (parameters) to a subroutine before its execution, enabling the subroutine to perform mathematical or logical operations on the data and return the results to the main program upon completion. These subroutines shall be accessed by jump-to-subroutine instructions.

3.13.59.   Program format. The program format shall display all instructions on a CRT/LCD programming panel with appropriate mnemonics to define all data entered by the programmer. The system shall be capable of providing a "HELP" instruction which, when called by the programmer, shall display on the CRT a list of instructions and all data and keystrokes required to enter an instruction into the system memory.

3.13.60.   Displayed system memory. At the request of the programmer, data contained in system memory shall be displayed on the CRT/LCD programming panel. This monitoring feature shall be provided for input/output status, timer/counter data, files, and system status. Ladder logic rungs shall be displayed on the CRT with rung numbers in sequential order. However, the programmer shall have the option of selecting and displaying logic rungs noncontiguously. Sequential function charts shall be displayed on the CRT/LCD. Structured text shall be displayed on the CRT.

3.1 3.61.   Addressing comments. The system shall have the capability to enter address comments and symbols. These entities shall have the capability to be entered at the same time the ladder logic is entered.

3.13.62.   Manually setting. The capability shall exist to manually set (force) either ON or OFF all hardwired input or output. Removal of these forced I/O points shall be either individually or totally through selected keystrokes. The programming terminal shall be able to display forced I/O points.

3.13.63.   Fault recovery. A means to program a fault recovery routine shall exist. When a major system fault occurs in the system, the fault recovery routine shall be executed and then the system shall determine if the fault has been eliminated. If the fault is eliminated, program execution shall resume. If the fault still exists, the system shall shut down. A user shall have the option to either resume operation or to shut down upon fault detection.

3.13.64.   Fault routine. The capability shall exist for each program to have its own fault routine for program fault recovery and each having the same features as the controller based fault routine.

3.13.65.   interrupt routine. An interrupt routine shall be programmable such that the routine shall be an instruction and shall be supported to incorporate closed

loop control systems. The "proportional", "integral", and "derivative" elements shall be accessible to the user in order to tune a closed loop system. This instruction shall fully support floating-point math. An interrupt routine shall be programmable such that the routine shall be executed regularly. The interval at which the routine is executed shall be user-specified in the range of 1 to 65,535 ms. An interrupt routine shall be programmable such that the routines shall be executed based upon the input condition of one of the discrete hardware inputs in the processor chassis. The routine shall be executed within 2 ms of the detection of the input signal.

3.13.66. Software instruction set addressing. The CPU shall support indexed and indirect addressing of inputs and outputs, along with all data table words (integer, binary, floating point, timers, and counters) for the software instruction set.

3.13.67. Symbols. The ability to program control logic via symbols from the global database of the PLC processor shall exist.

3.13.68. Control program instruction. An instruction shall be available to give the control program diagnostic information, state control, and sequencing of a process simultaneously, while allowing the capability of user-friendly state programming techniques.

3.13.69. Diagnostic instructions. The system shall support both bit and word level diagnostic instructions.

3.13.70. Function block programming. The processor shall be able to edit, build, and execute logically constructed function block routine. These function blocks shall be executed either selectively, based upon application logic (transitions), or simultaneously. The ability to "zoom" in on a given routine shall be inherent to allow the user to quickly diagnose their application program. The overall effect of the function chart programming shall to be to provide a more efficient flow of the user's application program.

3.13.71. Event detection programming. To facilitate conditional event detection programming, output instructions shall include "one shot" instructions, which shall provide the capability of being triggered on either low-to-high (rising) or high-to-low (falling) rung conditions.

3.13.72. Debugging. To facilitate debugging, an "always false" instruction shall temporarily inhibit the execution of control logic.

3.13.73. Master control reset. The processor shall support Master Control Reset (Relay) type functionality to selectively disable sections of logic.

3.13.74. Trigonometric instructions. Trigonometric instructions supported shall include Sine, Cosine, Tangent, Inverse Sine, Inverse Cosine, and Inverse Tangent. These instructions shall fully support floating-point math.

3.13.75. Floating-point instructions. Additional floating-point instructions supported shall include Log 10, Natural Log, and Exponential.

3.13.76. Calculations. It shall be possible to complete complex, combined calculations in a single instruction, such as flow totaling or equations of the format ((A+ ((B-C)*D))/E).

3.13.77. <u>File function instructions</u>. File function instructions supported shall include Sort, Average, Square Root, and Standard Deviation.

3.13.78. <u>FOR-NEXT loop</u>. The processor shall include direct support of FOR-NEXT loop constructions.

3.13.79. <u>ASCII string manipulation instructions</u>. The processor instruction set shall provide support for a variety of ASCII string manipulation instructions such as search, concatenation, extraction, compare, and to/from integer conversion.

3.13.80. <u>Control logic functions</u>. The processor shall support control logic functions providing ASCII port control such as read, write, handshake line control, and buffer examination.

3.13.81. <u>Configuration</u>. The capability shall exist to configure control programs that consist of hybrid control functions combining both relay ladder logic, sequential function chart operations, and structured text operations.

3.13.82. <u>Communication</u>. The programmable controller shall communicate with remote I/O racks or other PLCs via fiber optic cable by inserting fiber optic converters into the links. The fiber link shall support distances between converters up to 6500 cable feet. Redundant fiber optic cabling shall be an option.

3.13.83. <u>Program Storage and Upload</u>. The capability shall exist for the PLC program to be stored in a text format on a PC based computer. The saved text file shall be directly modifiable and then uploaded to the PLC processor.

3.14. <u>Diagnostics and state control</u>. The programmable controller system shall be capable of supporting the diagnostic functions indicated.

3.14.1. <u>Diagnostic instruction</u>. A diagnostic instruction in the PLC processor shall be capable of executing level 1, level 2, or level 3 diagnostics. Level I diagnostics shall use control logic for control with control logic fault detection logic setting fault bits that are monitored by the instruction for diagnostic message generation only. Level 2 diagnostics shall use control logic to control outputs, but the instruction shall monitor inputs and conditions to detect faults and generate a diagnostic message. In level 3 diagnostics, the instruction shall control outputs, monitor inputs for state control, perform diagnostic detection, and generate a diagnostic message.

3.14.2. <u>Diagnostic messages</u>. Diagnostic messages shall be assembled automatically using text from the PLC processor documentation such as address comments, symbols, step names, instruction comments, processor name, and other accessible PLC parameters. These fragments shall be user configurable in terms of size and usage. These automatic messages shall not require pre-storage by the user as they are dynamically assembled and generated.

3.14.3. <u>Network multiple PLC processors</u>. It shall be possible to network multiple PLC processors, each of which shall report diagnostic information to a common terminal.

3.14.4. <u>Diagnostic messages</u>. The system shall provide the following types of diagnostic messages:

3.14.4.1. Status messages.
3.14.4.2. Error messages.

4. INDUSTRIAL ETHERNET (IE) ENCLOSURES

4   Industrial Ethernet Switch Requirements

4.1   Physical

    4.1.1   Shall be DIN Rail Mountable

    4.1.2   Shall support dual sources of 24 VDC power

    4.1.3   The switch shall be modular and offer different size racks and various media modules

    4.1.4   The following rack sizes shall be offered:
           4.1.4.1   2-slot — can hold two interface modules — up to 8 interfaces
           4.1.4.2   4-slot — can hold four interface modules — up to 16 interfaces
           4.1.4.3   6-slot — can hold six interface modules — up to 24 interfaces

    4.1.5   The following types of interfaces shall be offered with the modules:

           4.1.5.1   100BASE-FL with ST connection
               4.1.5.1.1   These ports shall support full and half duplex operation

           4.1.5.2   10BASE-T/100BASE-TX with RJ45 connection
               4.1.5.2.1   These ports shall support:
                    4.1.5.2.1.1 Auto negotiation
                    4.1.5.2.1.2 Auto polarity
                    4.1.5.2.1.3 100 Mbit/s half duplex
                    4.1.5.2.1.4 100 Mbits/s full duplex
                    4.1.5.2.1.5 10 Mbit/s half duplex
                    4.1.5.2.1.6 10 Mbits/s full duplex

           4.1.5.3   100BASE-FX with MTRJ connection
               4.1.5.3.1   These ports shall support full duplex

    4.1.6   Interface modules shall be offered to contain all of one kind or a combination of interface types (e.g. 2 100BASE-FX and 2 twisted pair connections)

    4.1.7   The following indicators shall be provided on the switch

           4.1.7.1   Internal power supply voltage present
           4.1.7.2   Supply voltage 1 present or low
           4.1.7.3   Supply voltage 2 present or low
           4.1.7.4   Fault indicating there is some error

    4.1.8   The following indicators shall be provided on each interface module:

           4.1.8.1 Link status
           4.1.8.2 Full Duplex indication
           4.1.8.3 10/100 Mbits/s indication
           4.1.8.4 Auto-negotiate setting indication

4.2   Environmental

    4.2.1   Operating temperature shall be 0-60 degrees Celsius

4.3 Functional

4.3.1 Network Topology — Any line, star or ring topology shall be supported

4.3.2 Management

4.3.2.1 Management via SNMP Version 1/2/3 shall be supported
4.3.2.2 Web based management shall be supported
4.3.2.3 Management via a direct serial terminal connection

4.3.3 Multicast shall be supported

4.3.3.1 IGMP v1, v2
4.3.3.2 IGMP query

4.3.4 Virtual Local Area Networks (VLANs) as defined in IEEE 802.1Q shall be supported

4.3.5 Port Mirroring shall be supported

4.3.6 Auto-negotiation as defined in IEEE 802.3u shall be supported

4.3.7 Quality of Service (QOS) shall be supported

4.3.8 Port Prioritization as defined in IEEE 802.1 D/p shall be supported

4.3.9 Flow Control as defined in IEEE 802.3x shall be supported

4.3.10 Simple Network Time Protocol (SNTP) shall be supported

4.3.11 Rapid Spanning Tree Protocol (RSTP) as defined in IEEE 802.1w shall be supported

4.3.12 Precision Time Protocol (PTP) as defined in IEEE 1588 shall be supported

4.3.13 Bootstrap Protocol (BOOTP) shall be supported

4.3.14 Dynamic Host Configuration Protocol (DHCP) shall be supported

4.3.15 Broadcast Limiting shall be supported

4.3.16 The switch shall have the capability of "learning" and storing up to 4000 source addresses.

4.3.17 Shall support Dual Homing where there is a primary and secondary connection. Automatic failover to the secondary connection shall occur upon "loss of link" status on the primary connection.

5. CONTRACTOR GENERAL REQUIREMENTS

5.1   The Contractor shall assume single source responsibility for system assembly. An assembled system may include enclosures, mounting and wiring of relays, transformers, and disconnecting means, interface cables and connectors or other control devices as specified by customer-supplied documentation.

5.2   The Contractor shall have the capability to supply an enclosure with special paint and graphic displays. IE enclosures shall be offered in two styles - Stainless steel and Zinc coated steel.

5.3   The Contractor shall wire all Programmable Controller inputs and outputs to customer-specified terminal blocks.

5.4   The assembled system shall include fuse blocks that meets the Government size requirement that will be provided within 30 days after contract award.

5.5   Within the enclosures all I/O racks, processor racks, and power supplies shall be grounded to meet the specifications.

5.6   All pushbuttons, switches and other operator devices must be UL listed and/or CSA approved, and sufficiently large and durable to provide dependable, long life operation.

5.7   All cables (with associated plugs, connectors and receptacles) requiring user field installation, shall be designed for commercial use to withstand an industrial environment.

5.8   The Contractor shall submit preliminary drawings of the complete assembled system for approval by the Government.

5.9   The Government shall conditionally approve or disapprove the drawings within 15 days after receipt. Prior to approval of the preliminary drawings, the acquisition of materials or components for, or the commencement of production of, the MCS is at the sole risk of the contractor.

5.10 All drawings shall include page, sheet, and line numbers.

5.11 The first page of all drawings and schematics shall be a cover sheet consisting of a Bill of Material, purchase order number, Contractor's job number, user's name, location, application, and shipping address.

5.12 The drawings shall include a mechanical layout detailing the overall external dimensions of the enclosure. The drawings shall include such pertinent information as location of door handles, windows, lifting lugs, and enclosure mounted items such as tachometer or current meters, cooling fans, etc.

5.13 The Contractor shall provide documentation detailing the mounting of the processor, I/O racks, disconnect switch, fuse blocks, wireways, etc. All materials shall be labeled to provide easy cross-reference to the Bill of Material listing.

5.14 Electrical prints detailing all hardwiring, done by the Contractor, to devices such as relays, disconnect switches, fuse blocks, etc. shall be provided with individual wire numbers and relay contact cross-reference designations.

5.15 Sections describing inputs shall designate input modules by name, rack, module, and

terminal location.

5.16   The last sheet in the set shall be for terminal block designations each containing their individual terminal numbers.

5.17   At the time the equipment is shipped, one (1) reproducible copy of each drawing mentioned above shall be provided with the equipment.

6. Environmental Specifications

6.1   All material within the enclosures must be able to meet the following environmental requirements:

    6.1.1   Shock specifications must meet MIL-STD-901D, Grade A.

    6.1.2   Vibration specifications must meet MIL-STD-167 (Ships).

    6.1.3   RFI specifications must meet current version of MIL-STD-461.

    6.1.4   All material must be able to operate in 130^0F ambient environments.

    6.1.5   All material must be able to operate with external humidity ranging from 5% to 95% non-condensing.

    6.1.6   All enclosures designated as "submersible" shall conform to MIL-STD-108E, Notice 1. All enclosures designated as "drip-proof" shall conform to NEMA 4.

    6.1.7   All fiber optic connectors shall conform to MIL-C-83522/16B.

    6.1.8   All wire markers/labels shall conform to MIL-l-23053.

    6.1.9   All components used for enclosure penetration and sealing (i.e. strain relief, stuffing tubes etc.) shall conform to MIL-S-19622F.

    6.1.10   All CAT-5 copper cable shall conform to MIL-DTL-24643B.

    6.1.11   All fiber optic cable shall conform to MIL-PRF-85045F and MIL-PRF-49291C.

    6.1.12   All internal enclosure wire termination, routing, splicing, banding, securing and other electrical/electronic enclosure techniques shall conform to the standards of Electronic Installation and Maintenance Book (EIMB), NAVSEA 0967-LP-O00-0110.

6.2   The contractor shall provide environmental certification.

7. Requirements Acquisition

7.1.   The specific quantity of Machinery Control Systems (MCS) that will be required for installation aboard CVNs during the contract period are not known. Therefore, this procurement will be made through a "requirements contract." It is estimated that two complete MCS systems will be required during the first contract year, with one additional MCS system being required in each of the contract years two through four. The Contract Line Items (CLINs) included in Section B are organized so that CLINS 0001 through 0006 establish the price of components ordered during the first contract year, CLINs 0007 through 0012 establish the price of components ordered during the second contract year, CLINs 0013 through 0018 establish the price of components ordered during the third contract year, and CLINs 0019 trough 0024 establish the price of components ordered during the fourth contract year. Similarly, CLINs 0026 and 0027 have sub-line-items (SLINs) that establish pricing for each of the contract years. Each SLIN includes an estimated quantity to be procured, based on the assumptions stated above. Proposals should be based on those estimated quantities. However, contractors should understand that the actual number of MCS systems, and the actual number of each of the components ordered, will be based on the actual requirements of NAVSSES Code 91 during the contract period.

7.2.   Although enclosures are typically procured as a complete MCS system for a CVN, pricing will be on the component level rather than at the system level. This is because the actual components required for a complete MCS system varies from vessel to vessel. A typical MCS system would include between 50 and 75 enclosures. Attachments to this Procurement Specification include an example of the list of components that would be required for a particular MCS system ((in this case, the MCS system for CVN 75). There may be infrequent occasions when a small number of enclosures (10 or less) are required. See Clauses 52.216-19 and 52.216-19 in Section I of this Solicitation with respect to ordering limitations.

7.3.   The quantities specified are estimates only and will not necessarily be purchased. Refer to Clause 52.216-21 in Section I of this Solicitation for further information.

8. SPARE PARTS

For each MCS system, a spare parts list will be developed based the Mean Time Between Failure (MTBF) of each component. The life expectancy of each MCS shall be twenty years. Sparing recommendations (component level) are reflected in the estimated quantities of CLINs 0003, 0006, 0009, 00012, 0015, 0018, 0021 and 0024. Spare parts to support component level maintenance and repair should also be provided.

9. TECHNICAL SUPPORT

9.1 The Contractor shall be capable of providing support from home office, NSWCCD, and aboard ship. Personnel must possess knowledge of programming, hardware, and installation of the MCS systems for the length of this contract.

9.2 Engineering support will be requested on an as-needed basis and can range from one day to four months. This support may be required in non-consecutive days and may be spread out over the entire performance period of the contract.

9.4 Field services representatives shall provide miscellaneous material such as fuses, diodes, connectors, etc. in support of on-site service of MCS system.

10. TECHNICAL DOCUMENTATION

10.1. The Contractor shall provide a detailed assembly drawing for each enclosure.

10.2. The Contractor shall provide all required software necessary to operate system.

10.3. The Contractor may also provide software that is not mandatory for operation, but enhances system performance.

11. ATTACHMENTS

11.1   CVN75 I/O Box (PLC) Enclosure List (expected to be part of contract year 1 procurement)

11.2   CVN75 Ethernet Switch (IE) Enclosure List (expected to be part of contract year 1 procurement)

11.3   Estimated Quantities for contract years 2 through 4.

TYPICAL MCS ENCLOSURE LIST FOR CVNS

Box No.	Box Size	Type	Slot 0	Slot 1	Slot 2	Slot 3	TB1 Slot 4	TB2 Slot 5	TB3 Slot 6	TB4 Slot 7	TB5 Slot 8	TB6 Slot 9	TB7 Slot 10	TB8 Slot 11	TB9 Slot 12	TB10 Slot 13
1.1	24x24x8	SUB	ENET	ENET	PM	PLC	IAN	AR3	ACN	AR3	AVN	AR3				
1.2	24x24x8	SUB	ENET		PM		IAN	IAN	IAN	QAN	QAN	QAN				
1.3	24x24x8	SUB	ENET		PM		IAN	IAN	IAN	QAN	QAN	QAN				
1.4	24x24x8	SUB	ENET		PM		IAN	IAN	IAN	QAN	QAN	QAN				
1.5	24x24x8	SUB	ENET		PM		IAN	IAN	IAN	QAN	QAN	QAN				
2.1	24x24x10	D-H	ENET	ENET	PM	PLC	AOC	IAN	QKW	IAI	ACN	AR3				
3.1	24x24x10	D-H	ENET	ENET	PM	PLC	IAN	IAN	IAN	IAN		AR3				
3.2	24x24x10	D-H	ENET		PM		IAI	ACN		QK6						
3.3	24x24x10	D-H	ENET		PM		IAN	IAN	IAN	QAN	QAN	QAN				
3.4	24x24x10	D-H	ENET		PM		IAN	IAN	IAN	QAN	QAN	QANM				
3.5	24x24x10	D-H	ENET		PM		IAN	IAN	IAN	QAN	QAN	QAN				
3.6	24x24x10	D-H	ENET		PM		ACN	ACN	IDN	ACN	IDN					
3.7	24x24x10	D-H	ENET		PM		IAI	QK6	ACN	ACN	IDN					
3.8	24x24x10	D-H	ENET		PM		IAN	IAN	IAN	QAN	QAN	IDN				
3.9	24x24x10	D-H	ENET		PM		IAN	IAN	IAN	IAN	IAN					
3.10	24x24x10	D-H	ENET		PM		IAN	IAN	QAN	QAN						
3.11	24x24x8	D-H	ENET		PM		IAN	IAN	IAN	IAN	IAN					
3.12	24x24x8	D-H	ENET		PM		IDN	ACN	ACN							
3.13	24x24x8	D-H	ENET		PM		IAN	IAN	IAN	QAN	QAN	QAN				
4.1	24x24x10	D-H	ENET	ENET	PM	PLC	IAI					AR3				
4.2	30x36x8	D-H	ENET		PM		QKX	ISN	QDN	ISN	QDN	ISN	QDN	ISN	QDN	
4.3	24x24x10	D-H	ENET		PM		IAI									
4.4	24x24x10	D-H	ENET		PM		IAN	ACN	IAI	AR3						
4.5	24x24x10	D-H	ENET		PM		IAI	IAI		ACN						
4.6	24x24x10	D-H	ENET		PM			ISN	QDN							
5.1	24x24x8	D-R	ENET	ENET	PM	PLC	AR3	AR3	AR3	AR3	AR3	ACN				
5.2	24X24X8	D-R	ENET	ENET	PM	PLC	IAN	IAN	IAI	QKW	QKW	IAI				
5.3	24X24X8	D-R	ENET		PM		IAI		QKW	QKW	IAI					

Attachment 11.1

Box No.	Box Size	Type	Slot 0	Slot 1	Slot 2	Slot 3	TB1 Slot 4	TB2 Slot 5	TB3 Slot 6	TB4 Slot 7	TB5 Slot 8	TB6 Slot 9	TB7 Slot 10	TB8 Slot 11	TB9 Slot 12	TB10 Slot 13
5.4	RKMTD	RACK	ENET	PM	ISN	ISN	ISN	QDN32	QDN32							
5.5	RKMTD	RACK	ENET	PM	ISN	ISN	ISN	QDN32	QDN32							
5.6	RKMTD	RACK	ENET	PM	ISN	ISN	ISN	QDN32	QDN32							
5.7	RKMTD	RACK	ENET	PM	ISN	ISN	ISN	QDN32	QDN32							
5.8	RKMTD	RACK	ENET	PM	ISN	ISN	ISN	QDN32	QDN32							
5.9	RKMTD	RACK	ENET	PM	ISN	ISN	ISN	QDN32	QDN32							
5.10	RKMTD	RACK	ENET	PM	ISN	ISN	ISN	QDN32	QDN32							
5.11	RKMTD	RACK	ENET	PM	ISN	ISN	ISN	QDN32	QDN32							
5.12	RKMTD	RACK	ENET	PM	ISN	ISN	ISN	QDN32	QDN32							
5.13	RKMTD	RACK	ENET	PM	ISN	ISN	ISN	QDN32	QDN32							
6.1	24x24x10	D-H	ENET	ENET	PM	PLC	IAI	IAI		ISN	QDN	AR3				
6.2	24x24x8	D-H	ENET		PM		IAI	IAI		ACN	AR3	IAN				
7.1	24x24x10	D-H	ENET	ENET	PM	PLC	IAN	QAN	QKX	ACN	ACN	AR3				
7.2	24x24x10	D-H	ENET		PM		IAN	ACN	QAN	QKX						
7.3	24x24x8	SUB	ENET		PM		ACN	ACN	IDN		AOC					
8.1	24x24x10	D-H	ENET	ENET	PM	PLC		ISN	QDN	IAI		AR3				
8.2	24x24x10	D-H	ENET		PM		IAI			ACN		AR3				
9.1	24x24x10	D-H	ENET	ENET	PM	PLC	QKW	AOC	ACN	IAN	IAI	AR3				
9.2	24x24x10	D-H	ENET		PM		IAI	IAI		ACN	ACN	AR3				
10.1	24x24x8	D-H	ENET	ENET	PM	PLC	IAN	IAN	QAN	QAN	QKW	AR3				
10.2	24x24x8	D-H	ENET		PM		IAN	IAN	IAN	QAN	QAN	QAN				
10.3	24x24x8	D-H	ENET		PM		IAN	IAN	IAN	QAN	IAN					
10.4	24x24x8	D-H	ENET		PM		IAN	IAN	QAN	QAN						

Attachment 11.1

TYPICAL MCS ENCLOSURE LIST FOR CVNS

Box No.	Box Size	Type	Slot 0	Slot 1	Slot 2	Slot 3	TB1 Slot 4	TB2 Slot 5	TB3 Slot 6	TB4 Slot 7	TB5 Slot 8	TB6 Slot 9	TB7 Slot 10	TB8 Slot 11	TB9 Slot 12	TB10 Slot 13
10.5	24x24x8	D-H	ENET		PM		IAN	IAN	IAN	ACN	IDN					
10.6	24x24x10	D-H	ENET		PM		IAN	IAN	QAN	QAN	ACN					
10.7	24x24x8	SUB	ENET		PM		IAN	IAN	IAN	QAN	QAN	QAN				
10.8	24x24x8	SUB	ENET		PM		IAI	QK6	QK6	ACN	ACN	IDN				
10.9	24x24x10	D-H	ENET		PM		IAN	IAN	IAN	QAN	QAN	QAN				
10.10	24x24x10	D-H	ENET		PM		ACN	ACN	IDN	ACN	ACN					
10.11	24x24x10	D-H	ENET		PM		IAN	IAN	IAN	IAN	IAN	IAN				
10.12	24x24x10	D-H	ENET		PM		IAN	IAN	IAN	QAN	QANM	IDN				
10.13	24x24x10	D-H	ENET		PM		IAN	IAN	IAN	QAN	QAN					
10.14	24x24x8	D-H	ENET		PM		AVN	ACN	IAN	AR3	AR3	AR3				
10.15	24x24x8	D-H	ENET		PM		ACN	AR3	ACN	IAN	IAI					
11.1	30x36x8	D-H	ENET	ENET	PM	PLC	ACN	AR3	IAI	ISN	QDN	AR3				
11.2	24x24x8	D-H	ENET				ACN	IAI	AR3		AR3					
12.1	24x24x10	D-H	ENET	ENET	PM	PLC	ISN	QDN	ISN	QDN	ISN	QDN				
12.2	24x24x10	D-H	ENET		PM		QKW	QKW	QKW			AR3				

Attachment 11.1

TYPICAL MCS ENCLOSURE LIST FOR CVNS

IESW	Box Size	Type	Prim-ary Power	Switch A							Switch B					
				Type	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Type	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6
IESW NO 1	16x16x10	SUB	24V	4 Slot	4_Cat5	2_Cat5/2_FO	4_cat5	4_Cat5									
IESW NO 2	16x16x10	D-H	24V	2 Slot	2_Cat5/2_FO	2_Cat5/2_FO											
IESW NO 3	24x24x10	D-H	24V	6 Slot	4_FO	2_Cat5/2_FO	4_Cat5	4_Cat5	4_Cat5	4_Cat5							
IESW NO 4	16x16x10	D-H	24V	4 Slot	2_Cat5/2_FO	2_Cat5/2_FO	4_FO	4_Cat5									
IESW NO 5	24x24x10	D-H	24V	4 Slot	2_Cat5/2_FO	2_Cat5/2_FO	4_Cat5	4_Cat5			4 Slot	2_Cat5/2_FO	2_Cat5/2_FO	4_Cat5	4_Cat5		
IESW NO 6	16x16x10	D-H	24V	2 Slot	2_Cat5/2_FO	2_Cat5/2_FO											
IESW NO 7	16x16x10	D-H	24V	4 Slot	2_Cat5/2_FO	2_Cat5/2_FO	2_Cat5/2_FO	4_Cat5									
IESW NO 8	16x16x10	D-H	24V	2 Slot	2_Cat5/2_FO	2_Cat5/2_FO											
IESW NO 9	16x16x10	D-H	24V	2 Slot	2_Cat5/2_FO	2_Cat5/2_FO											
IESW NO 10	24x24x10	D-H	24V	6 Slot	4_FO	2_Cat5/2_FO	4_Cat5	4_Cat5	4_Cat5	4_Cat5							
IESW NO 11	16x16x10	D-H	24V	2 Slot	2_Cat5/2_FO	2_Cat5/2_FO											
IESW NO 12	16x16x10	D-H	24V	2 Slot	2_Cat5/2_FO	2_Cat5/2_FO											

Attachment 11.2

I/O HARNESS TOTALS	QTY
ENET	79
PLC	13
PM	65
IAN	88
IAI	25
ISN	39
IDN	10
QAN	48
QKW	10
QKX	3
QK6	4
QDN	14
QDN32	20
AR3	29
ACN	26
AOC	3
AVN	2
QANM	2

IE MODULE TOTALS	QTY
2 Slot	6
4 Slot	5
6 Slot	2
4_Cat5	17
2_Cat5/2_FO	24
4_FO	3

I/O & IE BOX TOTALS	QTY
16x16x10 Hinged Drip-Proof (D-H)	8
16x16x10 Submersible (SUB)	1
24x24x8 Submersible (SUB)	8
24x24x8 Removable Drip-Proof (D-R)	3
24x24x8 Hinged Drip-Proof (D-H)	12
24x24x10 Removable Drip-Proof (D-R)	0
24x24x10 Hinged Drip-Proof (D-H)	34
30x36x8 Hinged Drip-Proof (D-H)	2
Rack Mounted I/O Buckets (RACK)	12

Notes

1 Typical CVN system consists of 12 PLC Groups.
2 PLC Group 5 has 2 PLCs for redundancy, 13 PLCs total
3 12 PLC groups account for 66 boxes
4 12 IE boxes increase total to 78
4_Cat5 = 4 Cat5 connection for slot
6 FO = Fiber Optic
7 The ENET, PLC and PM modules do not require a harness
8 Remaining harness descriptions contained in Section 1.9

(End of Summary of Changes)